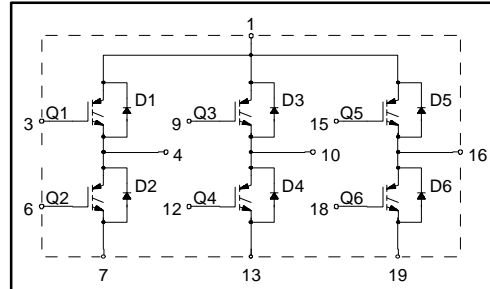


### IGBT SIP MODULE

### Fast IGBT

#### Features

- Fully isolated printed circuit board mount package
- Switching-loss rating includes all "tail" losses
- HEXFRED™ soft ultrafast diodes
- Optimized for medium operating frequency (1 to 10kHz) See Fig. 1 for Current vs. Frequency curve



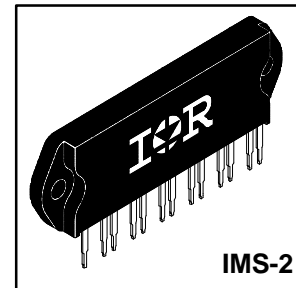
#### Product Summary

##### Output Current in a Typical 5.0 kHz Motor Drive

12 A<sub>RMS</sub> per phase (3.8 kW total) with T<sub>C</sub> = 90°C, T<sub>J</sub> = 125°C, Supply Voltage 360Vdc, Power Factor 0.8, Modulation Depth 80% (See Figure 1)

#### Description

The IGBT technology is the key to International Rectifier's advanced line of IMS (Insulated Metal Substrate) Power Modules. These modules are more efficient than comparable bipolar transistor modules, while at the same time having the simpler gate-drive requirements of the familiar power MOSFET. This superior technology has now been coupled to a state of the art materials system that maximizes power throughput with low thermal resistance. This package is highly suited to motor drive applications and where space is at a premium.



#### Absolute Maximum Ratings

	Parameter	Max.	Units
V <sub>CES</sub>	Collector-to-Emitter Voltage	600	V
I <sub>C</sub> @ T <sub>C</sub> = 25°C	Continuous Collector Current, each IGBT	27	A
I <sub>C</sub> @ T <sub>C</sub> = 100°C	Continuous Collector Current, each IGBT	15	
I <sub>CM</sub>	Pulsed Collector Current ①	80	
I <sub>LM</sub>	Clamped Inductive Load Current ②	80	
I <sub>F</sub> @ T <sub>C</sub> = 100°C	Diode Continuous Forward Current	9.3	
I <sub>FM</sub>	Diode Maximum Forward Current	80	
V <sub>GE</sub>	Gate-to-Emitter Voltage	±20	V
V <sub>ISOL</sub>	Isolation Voltage, any terminal to case, 1 minute	2500	V <sub>RMS</sub>
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Maximum Power Dissipation, each IGBT	63	W
P <sub>D</sub> @ T <sub>C</sub> = 100°C	Maximum Power Dissipation, each IGBT	25	
T <sub>J</sub>	Operating Junction and	-40 to +150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting torque, 6-32 or M3 screw.	5-7 lbf•in (0.55-0.8 N•m)	

#### Thermal Resistance

	Parameter	Typ.	Max.	Units
R <sub>θJC</sub> (IGBT)	Junction-to-Case, each IGBT, one IGBT in conduction	—	2.0	°C/W
R <sub>θJC</sub> (DIODE)	Junction-to-Case, each diode, one diode in conduction	—	3.0	
R <sub>θCS</sub> (MODULE)	Case-to-Sink, flat, greased surface	0.1	—	
Wt	Weight of module	20 (0.7)	—	g (oz)

## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

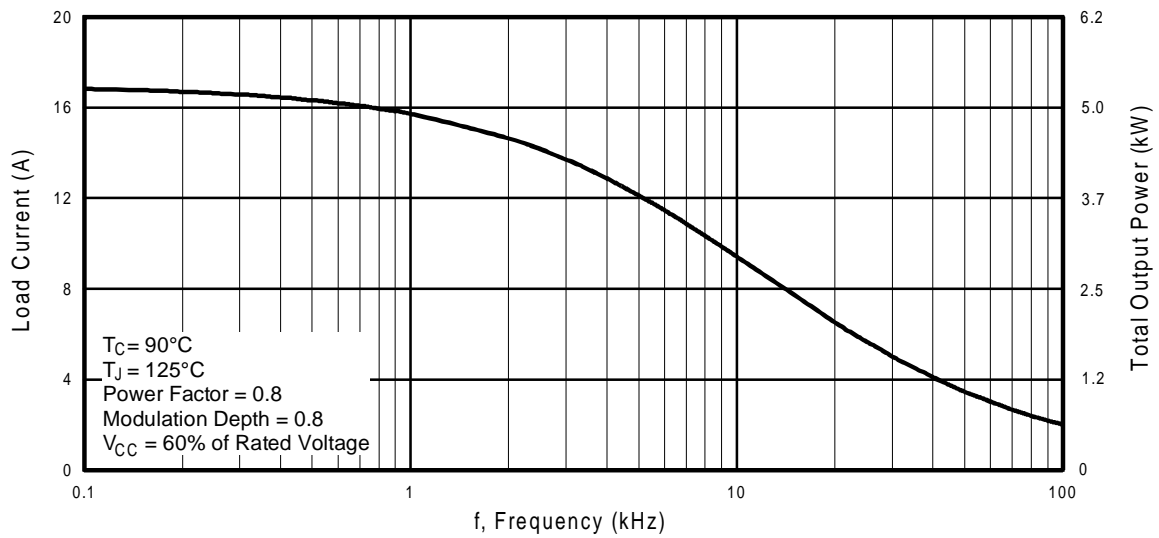
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage ③	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temp. Coeff. of Breakdown Voltage	—	0.69	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.4	1.6	V	$I_C = 15A$ $I_C = 27A$ $I_C = 15A, T_J = 150^\circ\text{C}$ $V_{GE} = 15V$ See Fig. 2, 5
		—	1.8	—		
		—	1.5	—		
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-12	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ④	9.2	12	—	S	$V_{CE} = 100V, I_C = 27A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	3500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	1.3	1.7	V	$I_C = 15A$ $I_C = 15A, T_J = 150^\circ\text{C}$ See Fig. 13
		—	1.2	1.6		
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 500$	nA	$V_{GE} = \pm 20V$

## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

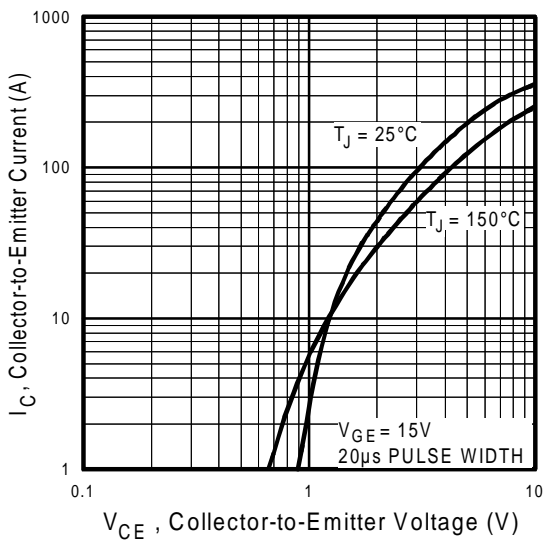
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	59	80	nC	$I_C = 27A$ $V_{CC} = 400V$ See Fig. 8
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	8.6	10		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	25	42		
$t_{d(on)}$	Turn-On Delay Time	—	26	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery See Fig. 9, 10, 11, 18
$t_r$	Rise Time	—	37	—		
$t_{d(off)}$	Turn-Off Delay Time	—	240	410		
$t_f$	Fall Time	—	230	420	mJ	$T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18 $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery
$E_{on}$	Turn-On Switching Loss	—	0.53	—		
$E_{off}$	Turn-Off Switching Loss	—	1.3	—		
$E_{ts}$	Total Switching Loss	—	1.8	2.8	mJ	$T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18 $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery
$t_{d(on)}$	Turn-On Delay Time	—	28	—		
$t_r$	Rise Time	—	37	—		
$t_{d(off)}$	Turn-Off Delay Time	—	380	—	ns	$T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18 $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery
$t_f$	Fall Time	—	460	—		
$E_{ts}$	Total Switching Loss	—	3.4	—		
$C_{ies}$	Input Capacitance	—	1500	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7
$C_{oes}$	Output Capacitance	—	190	—		
$C_{res}$	Reverse Transfer Capacitance	—	20	—		
$t_{rr}$	Diode Reverse Recovery Time	—	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig. 14 $T_J = 125^\circ\text{C}$ 14
		—	74	120		
$I_{rr}$	Diode Peak Reverse Recovery Current	—	4.0	6.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15 $T_J = 125^\circ\text{C}$ 15
		—	6.5	10		
$Q_{rr}$	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig. 16 $T_J = 125^\circ\text{C}$ 16
		—	220	600		
$di_{(rec)}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	188	—	A/ $\mu s$	$T_J = 25^\circ\text{C}$ See Fig. 17 $T_J = 125^\circ\text{C}$ 17
		—	160	—		

### Notes:

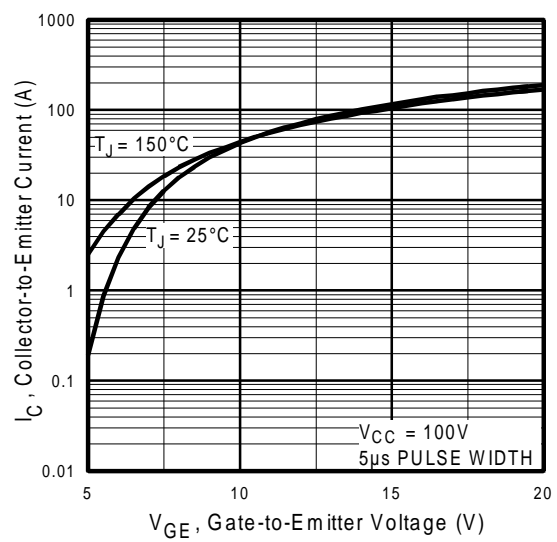
- ① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature. ( See fig. 20 )
- ②  $V_{CC}=80\%(V_{CES}), V_{GE}=20V, L=10\mu H, R_G=10\Omega$ , ( See fig. 19 )
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width 5.0 $\mu s$ , single shot.



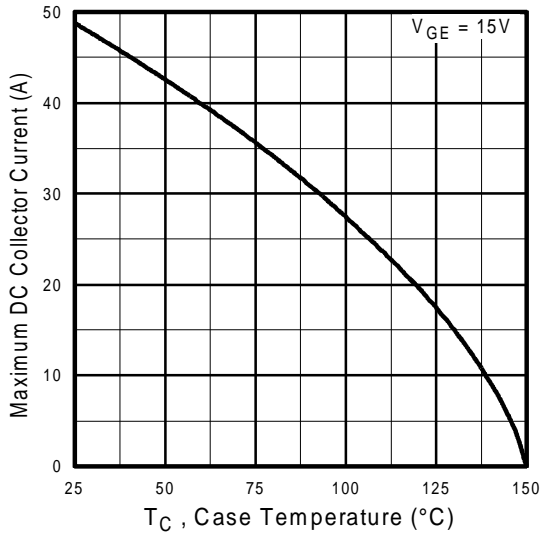
**Fig. 1 - RMS Current and Output Power, Synthesized Sine Wave**



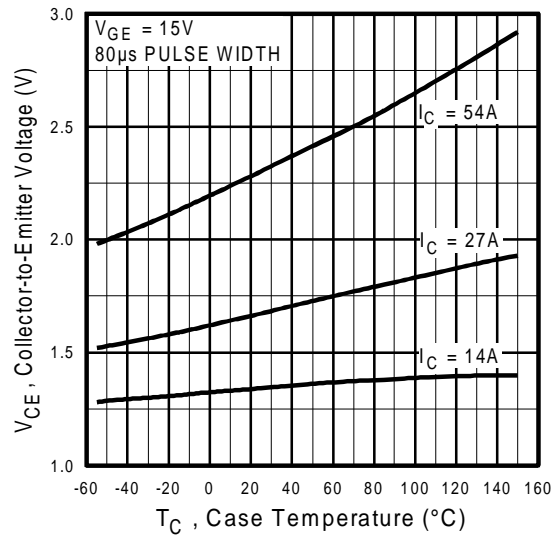
**Fig. 2 - Typical Output Characteristics**



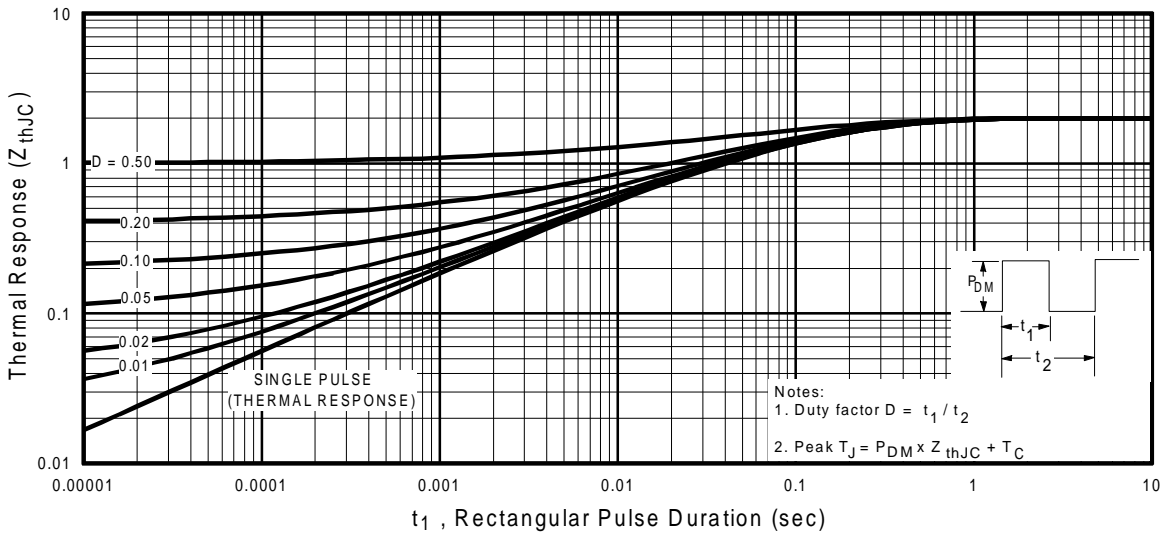
**Fig. 3 - Typical Transfer Characteristics**



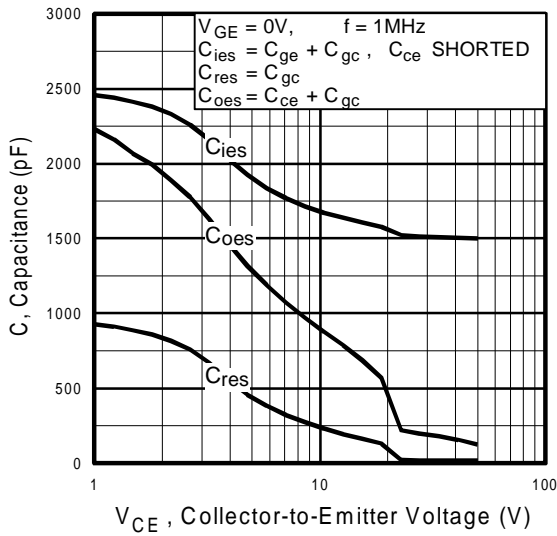
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



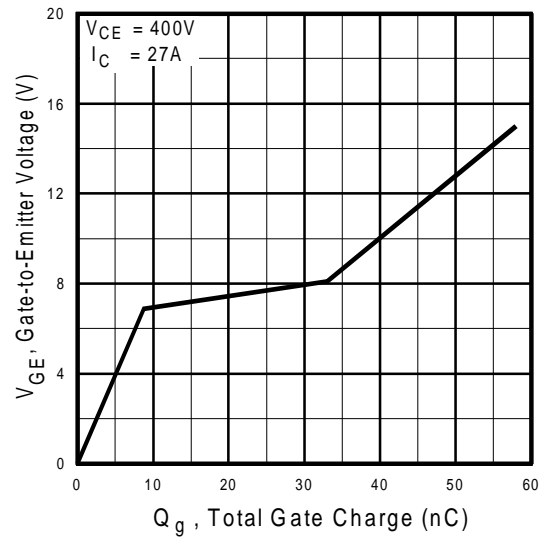
**Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature**



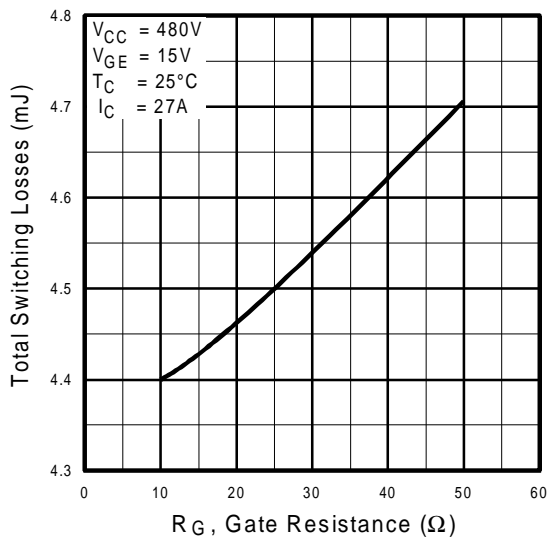
**Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case**



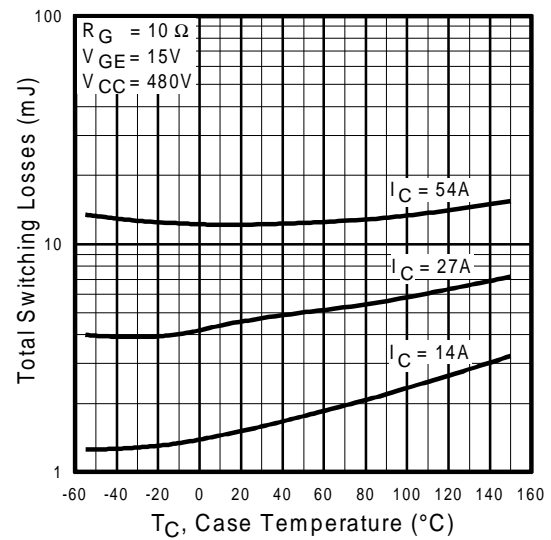
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



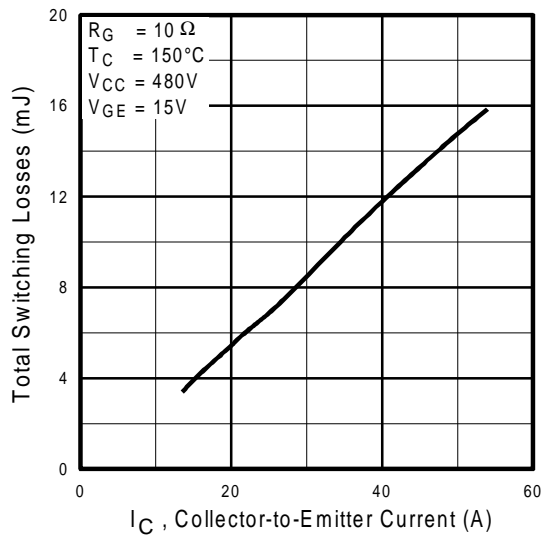
**Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage**



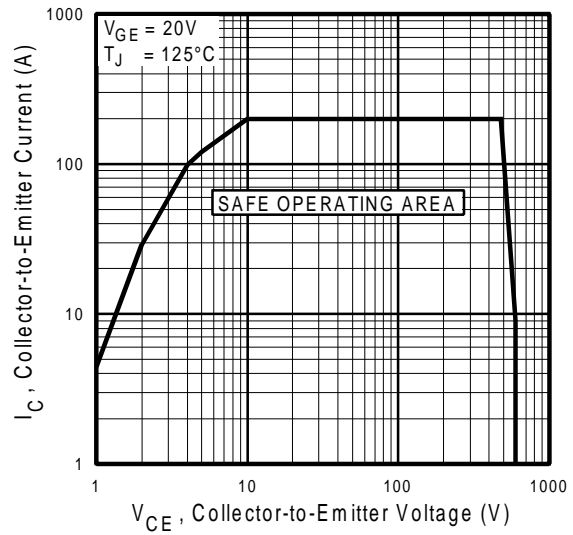
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



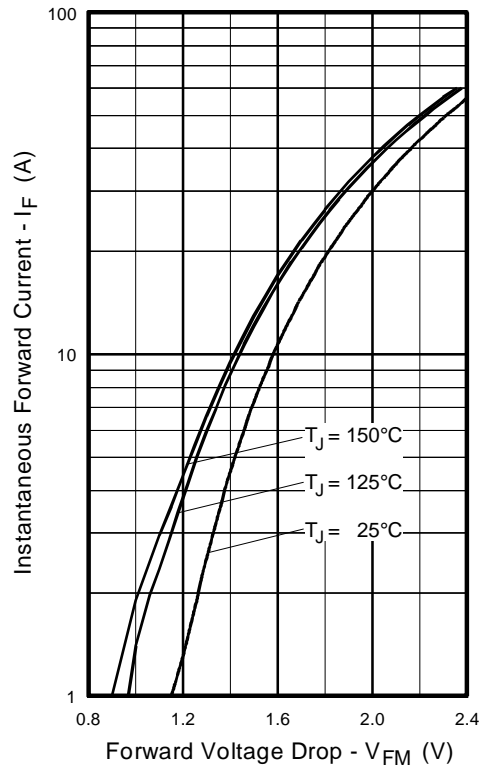
**Fig. 10 - Typical Switching Losses vs. Case Temperature**



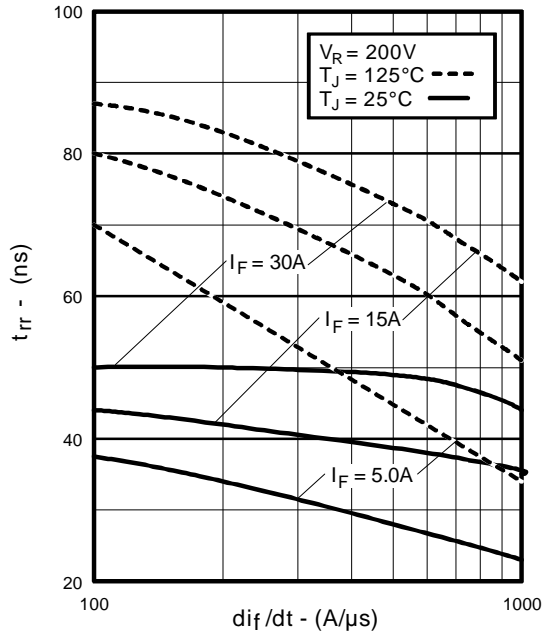
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



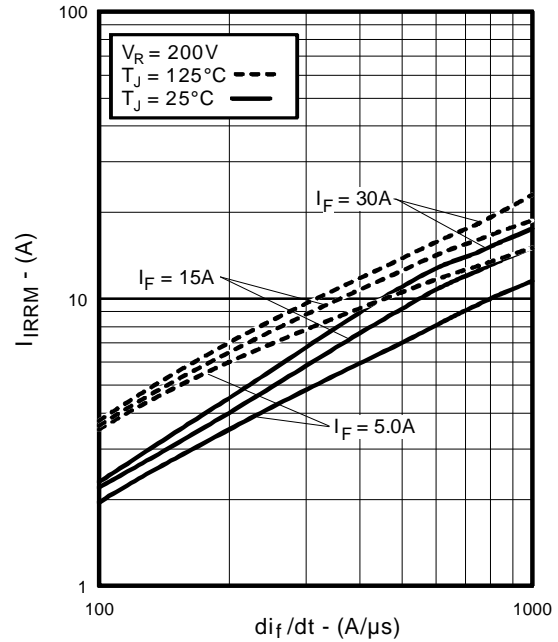
**Fig. 12** - Turn-Off SOA



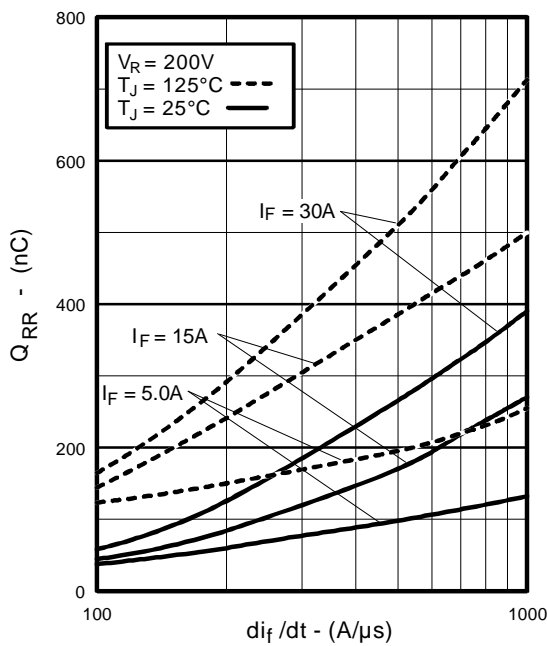
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



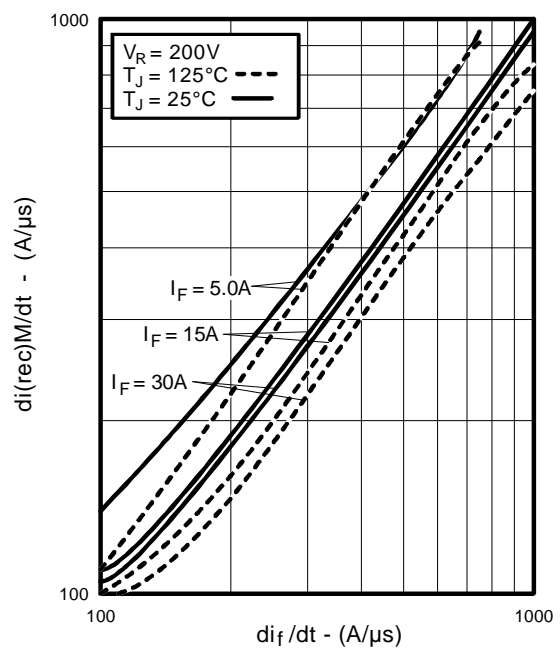
**Fig. 14 - Typical Reverse Recovery vs.  $dI/dt$**



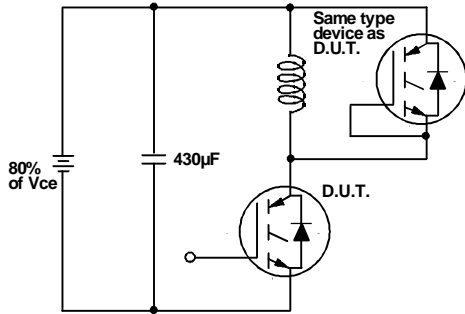
**Fig. 15 - Typical Recovery Current vs.  $dI/dt$**



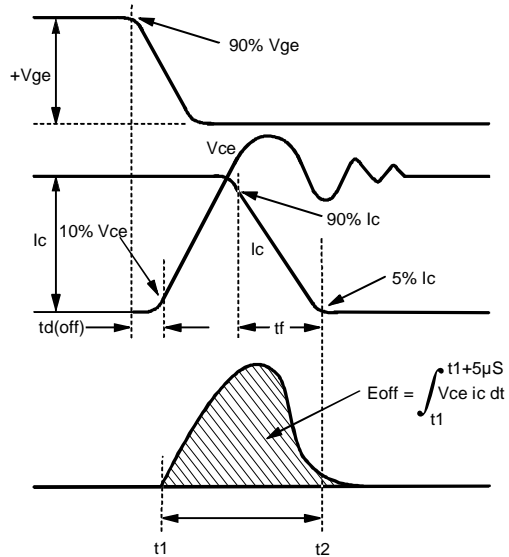
**Fig. 16 - Typical Stored Charge vs.  $dI/dt$**



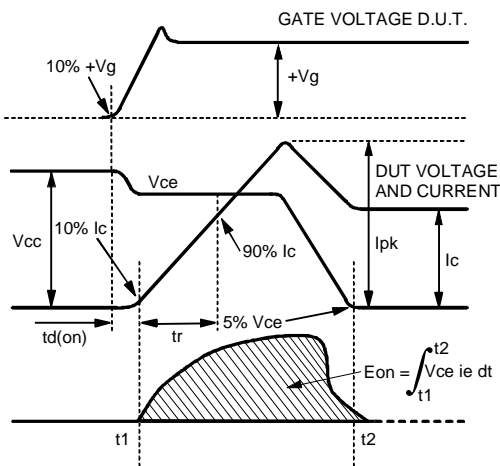
**Fig. 17 - Typical  $dI_{(rec)M}/dt$  vs.  $dI/dt$**



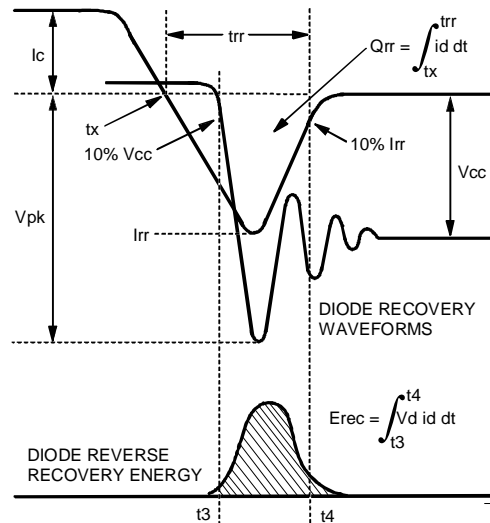
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

**Refer to Section D for the following:  
Appendix D: Section D - page D-6**

- Fig. 18e - Macro Waveforms for Test Circuit Fig. 18a
- Fig. 19 - Clamped Inductive Load Test Circuit
- Fig. 20 - Pulsed Collector Current Test Circuit